CHAPTER-1

INTRODUCTION

Pulses, being a rich source of protein, certain essential amino acids, minerals and vitamins (Khan, 1981 and Deshpande, 1992), constitute an integral part of the human diet, particularly of resource poor people of the country. Pulses are also used as forage to the animals for producing high-quality meat and milk (Boelt et al., 2014), besides fixing atmospheric nitrogen in the nodules in symbiosis with compatible Rhizobia as well as adding organic matter in the soil and thus play an important role in sustainable agriculture.

To make the availability of the balanced diet especially to poor people who cannot afford meat and poultry to meet their daily protein requirement, the unique complementation of pulses (dhal) with cereals is well emphasized globally. It is known fact that cereal proteins are deficient in certain essential amino acids, particularly lysine (Amjad, Khalil, & Shah, 2003) whereas, pulses contain adequate amounts of lysine, but are deficient in Sulphur containing amino acids (methionine, cystine and cysteine) (Farzana & Khalil, 1999) and consequently when pulses and cereals are mixed together in adequate quantity, a balanced food could be achieved that help to combat the mal-nutritional problems in developing countries.

It has been estimated that 40 to 60 million tonnes (mt) of N\textsubscript{2} are fixed by agriculturally important legumes annually, with additional 3 to 5 million tonnes fixed by legumes in natural ecosystems (Smil, 1999). This amazing efficiency of leguminous crops renders them as mini factory of nitrogenous fertilizer.

An effective management of nitrogen in the environment is one of the driving forces behind agricultural sustainability (Graham and Vance, 2000). Application of petroleum based nitrogenous fertilizers increased approximately 10-fold (about 90 million tonnes) between 1950 and 1995 (Frink et al., 1999) which is expected to be further enhanced by 2030 (Tilman, 1999). All these of course, need significant involvement of energy consumption as well as environmental pollution.
The over growing population are imposing an increasing demand for food supply which are of great concern on environment health and food security. Under this critical situation for agriculture, the widely acknowledged beneficial role of legumes in cropping systems, is more needed (Courty et al., 2014; Peix et al., 2014) for improving the physical property of the soil. It has been anticipated that India’s population would reach 1.68 billion by 2030 from the current level of 1.21 billion. Consequently, the estimated pulse requirement for the year 2050 is 39 million tonnes with the projected required growth rate of 2.14% (Anonymous, 2015). India has to produce not only enough pulses but also remain competitive to protect the indigenous pulse production. In view of this, India has to develop and implement more efficient crop production technologies along with favorable policies to promote farmers to bring more area under pulses.

Pulse-based cropping systems are more suitable for resource-poor farmers and water scarce regions as they are environmentally sustainable, require lower use of fertilizers, pesticides and irrigation in addition to enhancing the soil fertility which in turn help to increase the productivity of subsequent crops (Reddy 2004, Reddy 2009a) with reduced fertilizers application.

More recently, under the National Food Security Mission (NFSM), high priority has been given to increasing the production of pulses across the country to reduce protein malnutrition, restrict growing imports, and make pulses reasonable to the common man. The highest share of pulses, grown across the country are coming from Madhya Pradesh (24%), Uttar Pradesh (16%), Maharashtra (14%), Andhra Pradesh (10%), Karnataka (7%) and Rajasthan (6%), which together share about 77% of the total pulse production, while the remaining 23% is contributed by Gujarat, Chhattisgarh, Bihar, Orissa and Jharkhand.

Besides India, pulses are also grown in Africa, America, Australia, Malaya, East and West Indies, Pakistan, Bangladesh, Sri Lanka etc. Among pulses, chickpea occupies the major share (45.1%), followed by pigeonpea (15.7%), mungbean (9.9%), urdbean (9.6%) and lentil (7.3%), which together account for 87% of the total pulses production. Much of the pulses production has been slowly shifted from kharif to rabi and now the rabi share is increased to about 61.0% of the total pulses production. The
research and development investments on each crop should be in proportion to the share of the crop in the respective category (Reddy et al., 2013).

In India, the area, production and productivity of pulses in 1970-71 was 22.5 million hectares, 11.8 million tonnes and 524 kg per hectare, respectively which now (2013-14) stand 25.23 million hectares, 19.27 million tonnes and 764 kg per hectare, though required quantity is around 22 million tonnes to meet our growing population. Consequently, the per capita availability of the pulses has declined from 64 g/capita/day in 1951-56 to 39.4 g/capita/day in 2014-15 against the FAO/WHO’s recommendation of 80 g/capita/day. Percentage share of pulses in net food grain availability has also increased slowly from 7% to 8.33% during this period.

The genus *Vigna* comprised of more than 200 species that are native to the warm regions of both the Old world and New world. *Vigna* is closely related to *Phaseolus*, which is composed of more than 20 species that are native to warm or tropical regions of the New World. A number of species previously placed in *Phaseolus* are now placed in *Vigna*. The note worthy species of *Vigna* having considerable economic importance as dietary staples for millions of people in developing countries, are mungbean [*V. radiata* (L.) Wilczek], urdbean [*V. mungo* (L.) Hepper] and cowpea [*V. unguiculata* (L.) Walp.] besides, adzukibean [*V. angularis* (Willd.) Ohwi & Ohashi], bambara groundnut [*V. subterranea* (L.) Verdc.], mothbean [*V. aconitifolia* (Jacq.) Marechal] and ricebean [*V. umbellata* (Thunb.) Ohwi & Ohashi]. Many of these *Vigna* species are also valued as forage, cover and green manure crops in many parts of the world (Fery, 2002).

Among the several pulses grown, greengram [*Vigna radiata* (L.) Wilczek] and blackgram [*Vigna mungo* (L.) Hepper] are the important grain legumes being grown throughout the year (*kharif*, *rabi* and summer seasons) in our country, though in Uttar Pradesh, it is mainly grown in *kharif* and summer season.

Mungbean is thought to be native of India and Central Asia. According to Vavilov (1926), mungbean originated in India and *V. sublobata* (Roxb.) which occurs in a wild state in the sub-Himalayan region, is considered as the progenitor of mungbean. Mungbean is a strictly self-pollinated crop and belongs to family
**Fabaceae** (formerly **Leguminosae**) and sub-family **Papilionaceae** having somatic chromosome number of 2n=22. The mungbean proteins are quite simple, highly digestible and free from flatulent effects and consequently, recommended as a medicinal diet for the patient.

Mungbean, is an annual, erect or sub erect plant, sometimes slightly twining at the tips. The leaves are alternate, trifoliate, ovate and dark or light green. The inflorescence is an axillary raceme bearing yellow flowers and the keel is spirally coiled with a horn-like appendage. Pods are long, slender, containing 6-10 globose, round or elongated seeds which are mostly green but sometimes yellow, tawny brown, black or mottled in colour. The hilum is flat having epigeal germination (Baily, 1970).

The area, production and productivity of mungbean during 1984-85 were 2.84 mha, 1.05 mt and 371 kg/ha, respectively which now (2013-14) stands 3.38 mha, 1.61 mt and 474 kg/ha, clearly indicating marginal enhancement in production and productivity for the last few decades. In Uttar Pradesh, from an area of 0.79 (lac ha), the production of mungbean was 0.39 (lac tonnes) with an average productivity of 494 (kg/ha) during 2013-14 (Anonymous, 2014).

To meet the requirement of pulses, mungbean being a short duration crop maturing within 60 days, might be the best option for enhancing the production of pulses as it may be well fitted in rice-wheat cropping system without compromising the area of kharif/ rabi cereal crops.

Seed yield is an important trait as it measures the economic productivity of any crop plants, but its inheritance is extremely complex. The classical breeding systems that make use of additive genetic variance will be most effective breeding procedures for improving self pollinated crop like, mungbean.

Combining ability analysis is frequently executed to study the general combining ability (GCA) of the parents and specific combining ability (SCA) of the crosses, besides analyzing the nature of gene effects governing yield and related traits. This information would be helpful for the breeder to locate the desirable parents to be used in crossing program as well as to identify the superior hybrids (Murthy, 1975).
In any classical breeding programme, breeder cannot overlook the role of epistasis, otherwise he would obtain biased estimates of additive and dominance components of genetic variation which would lead to faulty breeding procedure (Singh & Singh, 1974a). Moreno (1994) suggested that interaction between genes is an important source of genetic variability. In literature, very limited information is available on all types of gene effects involved for controlling the seed yield and its components in mungbean (Khattak et al., 2001b).

The phenomenon of heterosis has generally been associated with the increased yield and vigour obtained by crossing among selected inbred lines which are developed by continued selfing of heterozygous cross pollinated crops. With the realization of the possibility of producing F1 hybrids on a large scale through male sterile lines, increasing attention has been diverted to achieve heterosis in self pollinated crops as well. However, the feasibility of heterosis breeding in self pollinated crops depends upon the availability of sufficient heterosis for characters of economic importance including grain yield and whether it is possible to fix such heterosis in pure breeding lines (Hayes and Foster, 1976) or for developing hybrid variety utilizing stable CMS (A, B and R) lines, if available.

The average yield of pulses in general and greengram in particular is very low as compared to that of cereals because of the lack of suitable high yielding varieties having synchronous maturity, instability under varying environmental conditions and susceptibility to number of biotic and abiotic factors. Among biotic factors, most prevalent diseases are Mungbean Yellow Mosaic Virus (MYMV), Cercospora Leaf Spot (CLS) and Powdery Mildew (PM) resulting poor yield. Therefore, there is an urgent need to develop high yielding varieties coupled with resistance to prevalent diseases with early maturity so that maximum seed yield could be harnessed which will ultimately enhance the total pulse production of the country.

Among biotic stress, the most devastating disease affecting mungbean production in South East Asia is Cercospora Leaf Spot (CLS), caused by the biotrophic fungus Cercospora canescens and Cercospora cruenta. The fungus initially causes spotting on mungbean leaves which increases in number and size during flowering, but
the increment is most rapid at the pod-filling stage, being usually observed in the month of September-October in eastern part of India. In susceptible varieties, infection expands rapidly resulting in premature defoliation and reduction in size of pods and seeds (Grewal et al., 1980), causing an yield loss varying from 23% to maximum of 61% (Iqbal et al.1995). Though, few donor for resistant to CLS are reported, they are not usually stable over years and locations (Chupp, 1953).

While studying the inheritance of CLS, Thakur et al., (1977) and Kaushal and Singh (1991) reported that resistance is governed by single dominant gene whereas, Mishra et al. (1988) reported that resistance is governed by single recessive gene. However, Anonymous (1980), Leabwon and Qupadissakoon (1984) and Srinivas (1991) reported that resistance is controlled by quantitative genes. These pieces of information are mostly based on inter-varietal crosses involving few parents. Information based on crossing large number of parents may be useful to isolate rare recombinants having high yield potential coupled with high degree of resistance to prevalent diseases. The success of breeding programmes mainly depends on the choice of superior parents for hybridization and clear-cut understanding of genetic system involved in the inheritance of the yield traits.

Identification of host resistance to any disease largely depends on the availability and efficiency of screening techniques. In a breeding program, it is imperative to screen the breeding material by creating artificial epiphytotic conditions for selecting resistant plants, thereby, avoiding any chance of escape. Further, for breeding resistant genotypes, it is worthwhile to assay the resistance to *Cercospora* leaf spot in terms of host biochemical defense, in addition to pathological characters. The significant role of sugars (Trelease and Trelease, 1929; Bhagat and Yadav, 1997) and phenols content (Rathi et al., 1998) towards *Cercospora* leaf spot resistance has been reported.

Selection of parental material is the most important task to initiate any crop improvement programme. Parental material can be screened at the adult stage for levels of various biochemical parameters associated with disease resistance. The study of inheritance of biochemical parameters will guide breeders to select appropriate breeding and selection procedures for handling the segregating material. For
stable production of mungbean over location and year, there is urgent need to understand the genetics of CLS resistance including associated biochemical constituents that may be helpful for developing the resistance varieties with high yield potential.

Keeping in view the above backdrops under consideration, the present piece of investigation entitled “Genetics of yield traits and biochemical constituents associated with resistance to Cercospora leaf spot in mungbean [Vigna radiata (L.) Wilczek]” was carried out with the following objectives:

- to analyses the biochemical constituents of parents and advanced generations.
- to estimate the gene effects of certain yield traits including biochemical constituents through generation means analysis.
- to study the genetics of resistance to Cercospora leaf spot.
- to study the combining ability variances and effects for yield and yield traits
- to estimate the magnitude of heterosis for yield and yield traits and its feasibility for enhancing yield in mungbean.

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